



Research paper

## Transport vulnerability: Measuring travel time and expenditure budget in Addis Ababa

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### ARTICLE INFO

#### JEL classification:

R00  
R20  
R23  
R28  
R40  
R41

#### Keywords:

Public transit  
Vulnerability  
Travel time  
Travel expenditure budget

### ABSTRACT

Public transport is critical for urban dwellers as it is a key link to access economic opportunities and social services. However, transit services in most developing nations are characterized by longer journey time, high fare, unsafe and uncomfortable travel. Hence, this study seeks to analyze the travel experience of public transit users through the lens of vulnerability. The main objective of the research is to investigate transit users' expenditure on travel, both in terms of time and money, which are regarded as "budgets" allocated to travel. The analysis is based on a survey distributed to 457 public transit users in Addis Ababa. The study applied proportions, percentages and cross-tabulation of key variables and statistical methods, such as one-way ANOVA to analyze the level of vulnerability of transit users. The result shows that low- and middle-income groups bear a higher level of travel burden, in terms of total travel time and percentage of income spent on transport than high income groups. Transport expenditure accounted above 20% of household income for 88% of low-income groups. However, it is below 15% of household income for high income groups, which reveals less financial burden on them. In terms of travel time, 63.8% of middle income groups experience a total travel time of more than 2 h and 52.3% of low-income groups but only 36.3% of high-income groups devote a total travel time above 2 h. Therefore, transport policy formulation should consider the needs and challenges of various groups of transit users.

### 1. Introduction

Transport is the means of (and the lack of transport is the impediment to) accessibility to jobs, health care facilities, education, and social services that are essential to the welfare of the society. Inaccessibility emerges as a major cause of social exclusion of the poor in urban areas (World Bank, 2002).

Public transit, together with other modes of transport such as walking and cycling, is the main mode of transport relied on by low-income groups (Baindur & Rao, 2016). As a result, affordable public transit is critical for low-income population. As it is argued by Cao et al., 2018 & Delbosc & Currie, 2011, people should have equal access to mass transit and one way to achieve equity is to provide public transit to individuals who need it most. However, providing equitable and efficient public transit services is a challenging task in the developing countries due to high population density, low financial capability, spatially separated land uses and ever-increasing demand with the limited

resource available (Agarwal et al., 2017).

Access to sustainable and affordable transport is critical for the urban dwellers, as it offers a way out from economic and social challenges. It is also a key link to access social services and livelihood assets. Affordable transport can also influence individual's assets, such as financial asset, in terms of travel cost. For most of low-income households, access to formal transit services is often out of their reach due to high fares. In other circumstances, unaffordable transport options that are available might lead to other stresses in terms of the journey time required and unsafe and uncomfortable travelling conditions (Lucas et al., 2016). Such transportation burden becomes a key issue affecting the quality of urban life. Transport costs have been increasing in many countries, with families spending a significantly larger percentage of their income on transport (Zhao & Li, 2016). The problem is highly pronounced on the low-income groups as they usually bear a high level of travel burden. In developing countries, travel times remain higher for the lower socio-economic groups.

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<https://doi.org/10.1016/j.retrec.2022.101247>

Received 9 February 2022; Received in revised form 4 July 2022; Accepted 15 November 2022

Available online 10 December 2022

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Public transit service characteristics coupled with individual features such as socio-economic status exacerbate the transport vulnerability situation of urban residents. For instance, among others, women and low-income groups face travel difficulties disproportionately in terms of their income paid more for transportation, as well as having longer travel times to access services (Dodson et al., 2006).

Hence, this paper aims to assess the experience of public transit users by employing the concept of vulnerability. The research will be useful in bringing important concepts and perspectives in the analysis of the social dimension of transport. On top of that, the result will also be useful in identifying the needs and priorities of vulnerable public transit users in policy formulation.

The paper is organized as follows: section 2 discusses the literature on vulnerability and its application in transport studies. Section 3 introduces data and methods, and section 4 presents the results of the study. Section 5 compares the findings with the previous literature and finally section 6 provides conclusion and recommendations.

## 2. Literature review

The social dimension of transport has become an important concern in sustainable transport literature and has attracted the attention of the academic world. Many newly emerged social concepts are used in transportation such as ‘transport poverty’ (Lucas et al., 2016), ‘transport-related social exclusion’ (Kamruzzaman et al., 2016), ‘transport disadvantage’ (Xiao et al., 2017), ‘transport equity’ (Lucas, 2012; Ciommo & Shifan, 2017) ‘transport vulnerability’ (Glensor, 2018; Lubitow et al., 2017). A growing number of literature addresses the subject of vulnerability in transport to issues such as transit users vulnerability (Lubitow et al., 2017; Glensor, 2018; Odufuwa, 2008; Odufuwa, 2010), and road network vulnerability (Berdica, 2002; Husdal, 2005; Jenelius & Mattson G, 2014).

In everyday use of language, the term vulnerability refers to the inability to withstand the effects of a hostile environment (Ciurean et al., 2015). Transport vulnerability is defined as a lack of personal or public transportation access (Agostino et al., 2020). Several studies highlight the importance of access to transport while studying the social implication of transport. Among others, Kamruzzaman et al. (2016); Yigitcanlar et al. (2018); Church et al. (2000) argued that social exclusion is not due to a lack of social opportunities but a lack of access to those opportunities. The term vulnerability has also been used in transportation literature to denote the nexus between transport and society.

The actual vulnerability arises from the interaction of individual characteristics, and external conditions within a context (Emrich & Cutter, 2011). For instance, peoples’ vulnerability in relation to transport service is influenced by the context in which they live in. This vulnerability context refers to the external environment in which people exist and have direct impact on people’s economic status. It consists of trends, shocks, and seasonality (Rakodi and Llyod, 2002). In the context of transport, trend includes population, car ownership, and policy trend while shocks can be expressed in terms of crime, harassment, accident. Seasonality refers to peak and off-peak hour experiences like price fluctuation and waiting time. All the three can be sources of vulnerability. Apart from this, individual characteristics can also be a source of vulnerability. For instance, fear of theft, attack or harassment on public transport is a barrier to travel, especially for women. For example, transit dependent riders described experiences of exclusion from the transit system in Portland; ranging from physical barriers to economic or social barriers linked to racism (Lubitow et al., 2017). In the same study, racial and ethnic minorities reported a range of everyday conflicts and subtle interactions that made them feel excluded when riding public transit.

Apart from individual level factors, many social and structural factors determine transportation vulnerability and its relationship to health. For example, transportation vulnerability is particularly high in areas with high racial/ethnic segregation. As stated by Agostino et al.

(2020) minority youth living in areas with high poverty and high segregation, for example, have poor access to transportation and transportation inequity is associated with low participation in healthy behaviors such as physical activity. So, the conceptualization of vulnerability highlights the interplay between the context and the conditions/characteristics of the individuals. Vulnerability can thus be seen, in this view, as a situational experience.

Public transit is the main means for those who lack access to a private car in most developing countries. Thus, its usage is higher among lower socio-economic groups than those in higher socioeconomic groups. Increased dependence on public transport also equates to a vulnerability to the problems associated with it. There are so many ways in which public transit dependent people experience vulnerability. The costs of public transport can be a particular difficulty for people on low incomes, and lack of available, adequate services have been identified by a range of studies as a greater obstacle. The literature on the social dimension of transport indicated that difficulties experienced in accessing transport limit individual’s abilities to participate in socio-economic activities. The literature also acknowledged the prominence of accessibility and cost of transportation in affecting individual’s participation in socio-economic activities (Lucas et al., 2016; Schwanen et al., 2015). As it is known, disparity exists in transport service accessibility and affordability among different social groups. For instance, high cost of transportation limit low-income peoples’ access to employment, social networks, as well as health, educational and other facilities. Women also restrict themselves from using public transit due to fear of harassment, and theft which will affect their ability to access employment and other essential services. The hassle associated in getting transit service including waiting time discourage people to make a trip especially for the trips considered to be low value such as visiting friends, recreation and so on (Goetz, 2019). In general, certain groups of society are more likely to experience transport disadvantage than others. The literature suggests that transport disadvantaged groups of the population potentially include low-income people, children and youth, women, elderly, disabled, outer urban dwellers, and ethnic minorities (Schwanen et al., 2015).

It has been reported that cities in developing countries of Asia, Africa and Latin America have social problems including poverty, social inequality and crime among others (World Bank, 2002). Consequently, social inequality is reflected in transport inequality as low-income earners often bear a higher commuting burden than middle- and high-income earners (Zhao & Li, 2016). A wide range of research has now demonstrated that transport service can limit access to social and economic activities and that this can both lower the quality of life and exacerbate social exclusion. To mention few of them, Fol and Gallez (2014), revealed that access to facilities, which is indicated by a combination of transport cost and time and the number of opportunities, is a key to transport related social exclusion. Zhao and Li (2016) also argued that excessive commuting time and monetary costs for disadvantaged groups is not only an indicator of the degree to which they are socially excluded but also a factor influencing further social exclusion, such as being prevented from participating in other social activities. For instance, Church et al. (2000) explore the link between transport and social exclusion. The paper revealed that social exclusion is the outcome of the inability of people to physically access opportunities because of travel difficulties. As stated by Solomon (2003), the connection between social exclusion and transport were found to be particularly marked among certain groups such as unemployed, families with young children, the youth, low incomes, older people, in all ethnic group. For many of them affordability was a key issue. Availability and accessibility also proved to be highly significant. In their study of vulnerability and exclusion, Lubitow et al. (2017) also indicated that the issue of affordability is central to the concerns of transit-dependent riders.

The transport sector has gone through changes with the introduction of technology which is manifested in the improvement of speed. Despite rapid increases in average travel speed, the daily travel time budget, on

average an hour per day, has held remarkably constant over time, from ancient Rome to the walking cities of 15th century Europe to the streetcar suburbs of the early 20th century and freeway-laced cities of today (Cervero, 2011). However, Joly (2004) argued that the hypothesized individual travel time budget seems to be valid at the world aggregate level only. It is not a valid hypothesis at disaggregate level, urban or regional. A number of studies have failed to find evidence of consistency in travel time budgets. For example, Stopher and Zhang (2011) in their analysis of travel time expenditure on a daily basis per person found that the mean time spent travelling is 53.6 min per day. Downs (2004) in a book *Stuck in Traffic* indicated that average travel time expenditure in urban areas ranges from 1 to 1½ h. Evidence from Bogota also suggests that travel time budget reaches 60 min per trip (Teunissen et al., 2014).

### 3. Data and methodology

#### 3.1. The study area

This study examined transport vulnerability in the capital city of Ethiopia, Addis Ababa. The city was selected for this study for several reasons. First, it is the predominant urban center in a country with a population of 5 million (United Nations & Department of Economic and Social Affairs Population Division, 2018). Second, in terms of economy, Addis Ababa alone currently contributes approximately 50% towards the National Gross Domestic product of the country (Feyissa et al., 2018). Third, there are significant low-income earners of the city that depend on public transportation. Public transportation is the major mode of travel in the city.

Urban transport in Addis Ababa is carried by a mixture of ownership structures, of which public and private operators are predominantly

contenders for business. *Anbessa* and *Sheger* Bus Enterprises are the two government-operated public transport modes that provide standard bus service in Addis Ababa and the LRT is also owned by the government (AACRA, 2014). Mini and midi buses (*Higer*) are private enterprises, mostly single vehicle owners. Like other cities of developing countries such as Zimbabwe (Mbara, 2006), Dhaka (Jahangir et al., 2021), Bogota (Teunissen et al., 2014), transport system has become in a state of crisis in Addis Ababa. Mobility demand has continued to increase, and supply falls below the demand. Therefore, transport shortfall is increasing transport vulnerability among different groups of the society.

The city’s government is headed by the mayor and the city council. The current governance structure of the city has three administration tiers, city level (central), sub city level, and *woreda* (district) level. The three tiers of the city administration constitute one city administration, 10 sub-cities (*Kefele Ketemas*) and 116 *woredas* (AACPPPO, 2016). Transport policies are guided by the Addis Ababa Transport Bureau.

#### 3.2. Data and method

The data used in this study were obtained from a survey distributed to public transit users on major transit stations in Addis Ababa. A convenience sampling technique was used to reach 457 respondents. Many of the intra urban transit stations are found along the LRT line and regional bus terminals. The transit spots for LRT also serve as transit exchange points with other modes of transport. Therefore, main transit station for both road and rail based transit were purposively selected as study sites. These are *Torhaliloch*, Stadium, *Megengna*, *Ayat*, *Merkato*, *Kality*, *Menelik square*, *Piazza*, and *Mexico*. In the literature, peripheral areas are cited as vulnerable (Glensor, 2018; Schewan et al., 2015). In terms of availability of infrastructure and services, people living in peripheral areas are said to be vulnerable to infrastructure or service

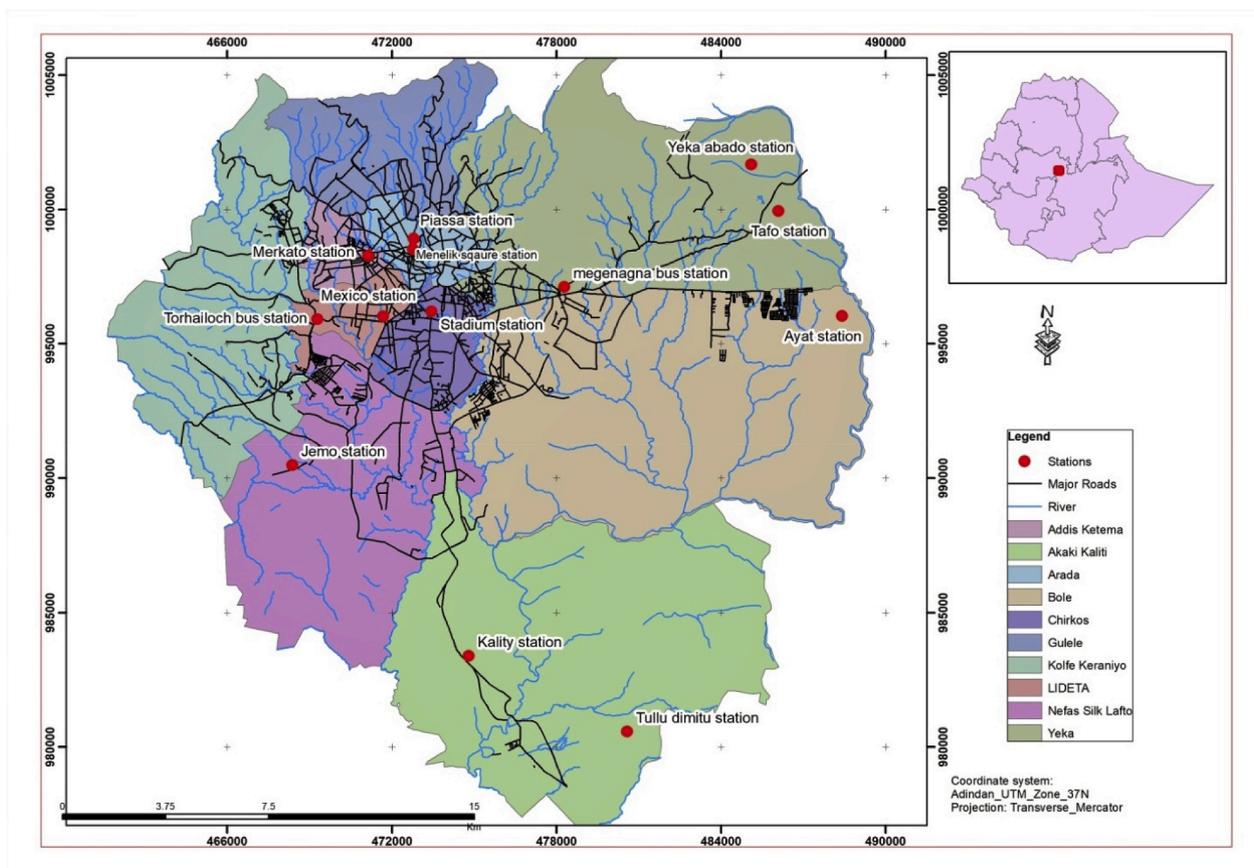


Fig. 1. Study stations.

deficiency (Lubitow et al., 2017). With this in mind, transit stations that are found in peripheral areas (mainly condominium areas) were purposively selected as study sites. These include *Jemmo*, *Yeka Abado*, *Tafo*, *Tullu dimitu* (see Fig. 1).

Data was collected from May 10 to July 15, 2021. 500 questionnaires were distributed but 457 of them were used for the analysis and the remaining 43 were discarded as they are not completely filled. Data were collected during the Covid-19 pandemic; however this doesn't affect the data collection as transit service didn't stop during the pandemic. We have strictly followed the precautions while collecting the data in the midst of global pandemic. From respondents who cannot read and write data was collected with the help of enumerators.

Information or data regarding travel time and expenditure gathered through a survey questionnaire. The survey included users personal and travel information such as age, gender, income, travel cost, travel time, and number of trips. In order to analyze the data, proportions, percentages and cross-tabulation of key variables were employed. Statistical methods, such as one-way ANOVA was used to test whether disparities among socio-economic groups are statistically significant.

The transport vulnerability measures/variables used in this paper mainly incorporates user income group, affordability and travel time budget. Public transit users' vulnerability was measured in terms of their travel time and travel cost burden. Monthly transport expenditures relative to total monthly household income and travel time budget were analyzed by income class. With regard to income classification, there is no national data that allow grouping of households in low-, middle- and high-income range. Many documents (Castaneda et al., 2016; World Bank, 2002; Rakodi & Lloyd-Jones, 2002) profile the characteristics of poor households using certain parameters such as education, health, access to road and shelter. Although there is no agreement found to define low- and high-income classification, the national poverty line defined as 3781 ETB in 2011 by the World Bank (2015), can be used to group people as poor and non-poor. A person working in Ethiopia typically earns around 8900 ETB per month. Salary ranges from 2250 ETB (lowest average) to 39,700 ETB (highest average) ([www.salaryexplorer.com](http://www.salaryexplorer.com)). Hence, income classification was done on the basis of the median income (6917.5) and average salary benchmarking. Accordingly, people with a monthly average household income below the median (less than the 6000 ETB) were classified as low-income groups. Those with average income around the median and average salary (between 6000 and 10,000 ETB) were defined as middle income. People who have a monthly average household income above 10,000 ETB were classified as high-income groups.

Total travel time, which in this study, is the sum of waiting and actual travel duration. Thus, major transit time components, peak hour waiting time and travel duration, were considered to compute total travel time budget of respondents. The most common approach to measure affordability is to estimate the proportion of household income or expenditure spent on public transport (Falavigna & Hernandez, 2016; Gómez-Lobo, 2011; World Bank, 2011). Affordability index, expressed as percent, was also computed using the formula provide by Carruthers et al. (2005): (number of trips\*average cost per trip)/per capita income. Regarding income level, income ranges of households were computed, and the medians of the different income ranges were used in estimating the proportion of income used for transport. Using this information, an average monthly expenditure/income ratio was computed for users of the various income groups.

The estimated percentage of monthly income spent on public transport has to be compared to an arbitrary benchmark considered affordable in order to give a better picture of the level of disparity in their proportion of income spend on transport. Affordability index benchmarks are given as a percentage of income spend on transport. Three thresholds of affordability index were used: less than 15%, 15–20%, above 20%. The thresholds are set based on the World Bank's recommendation or the suggestions from other literatures. For instance, World Bank (2011) suggests a travel expenditure of not more than 11%

of income as an affordable. Considering the combined housing and transport costs, it is suggested that to be affordable, households should be able to meet their basic mobility needs with less than 10% of their household budget, with a range from less than 5% if they have high housing costs (more than 40% of their budget), to more than 15% if they have low housing costs (less than 30% of their budget) (Litman, 2013).

Thus, the selected thresholds of affordability index, below 15%, within 15–20 and above 20, give an indication of transport vulnerability level. In the case of travel time, average travel time expenditure in urban area ranges from 1 to 1<sup>1/2</sup> h (Downs, 2004). Therefore, the level of vulnerability was determined by taking benchmark or standard values for each variable - travel time and travel expenditure. Percentages of households above or below the standard were defined as having higher level of transport vulnerability and vice versa.

## 4. Results

### 4.1. Socio-demographic characteristics of respondents

The survey respondents constituted 52.3% women and 47.7% are men (Table 1). With regard to employment status, most of survey respondents, close to 60%, are employed in government and privately owned companies that have daily fixed working times and then required to commute every day. More than 25% of them are engaged in personal business, both formal and informal. Few of them, less than 5% are housewives and pensioner who didn't have to travel every day to work, and the remaining are students.

More than half of the respondents are in the age group 26–45 years implying that they are working age groups who are required to commute on a daily basis. More than half of the respondents have a monthly income in the range of 4000–10,000 per month while 23% less than 4, 000 per month. The remaining 20% have a monthly income above 10,000 (see Table 1).

**Table 1**  
Socio-demographic profile of respondents.

| Variable                  | Category                    | %    |
|---------------------------|-----------------------------|------|
| Age                       | <18                         | 8.1  |
|                           | 18–25                       | 21.4 |
|                           | 26–35                       | 33.3 |
|                           | 36–45                       | 22.8 |
|                           | 46–55                       | 11.8 |
|                           | 56–65                       | 1.5  |
|                           | >65                         | 1.1  |
| Gender                    | Male                        | 47.7 |
|                           | Female                      | 52.3 |
| Level of education        | Cannot read and write       | .4   |
|                           | Write and read              | 2.8  |
|                           | Elementary (1–6)            | 2.0  |
|                           | Junior (7–8)                | 1.8  |
|                           | High (9–10)                 | 11.6 |
|                           | Preparatory (11–12)         | 7.2  |
|                           | Certificate/TVET            | 10.7 |
|                           | Diploma                     | 21.7 |
| Employment status         | Degree (BA/Bsc)             | 32.4 |
|                           | Masters (MA/Msc)            | 9.4  |
|                           | Government employed         | 29.3 |
|                           | Employed in private company | 30.6 |
|                           | Self-help (Formal)          | 20.4 |
|                           | Self-help (Informal)        | 6.8  |
|                           | Housewife                   | 1.3  |
| Household income (In ETB) | Pensioner                   | 1.3  |
|                           | <1000                       | 2.4  |
|                           | 1001–2000                   | 4.2  |
|                           | 2001–4000                   | 13.1 |
|                           | 4001–6000                   | 13.8 |
|                           | 6001–8000                   | 18.2 |
|                           | 8001–10,000                 | 20.6 |
| Above 10,000              | 17.5                        |      |

\*ETB = Ethiopian Birr (Ethiopian currency).

Educational levels of the respondents range from those without formal education to Master’s degree holders. Those who can’t read and write represent a very small percentage, 0.4%. Those who have a lower educational attainment (who can read and write) also account 2.8%. This actually signals the increasing efforts being undertaken by the government in increasing literacy rate across the country. Those who attend primary school education (1–6) represent 2%, junior school (7–8) 1.8%, and high school (9–10) 11.6%. Preparatory school (11–12) takes 7.2%. TVET (Technical and Vocational Education and Training) certificate accounted 10.7% while diploma holders accounted 21.7%. Bachelor’s degree holders represent 32.4% and 9.4% of the respondents are Master’s holders and above (see Table 1).

4.2. Travel characteristics of respondents

As it can be seen form Table 2, close to 54% of the respondents spend more than 2 h for their one-way home to work trip followed by 16% which goes to a total travel time between 31 and 60 min. A small percentage, 8.8% have a total travel time of less than 30 min. The same percentages, 10% of respondents have a total travel time between 61-90 and 91–120 min. This scenario may depict the experience of short and long-distance travelers.

The result in Fig. 2 shows that all modes of transport have higher travel time record. This is mainly attributed to the impact of congestion in the city. For example, 94% of Higer, 83% of Sheger and 77% of Anbessa users spent more than 2 h for their home to work trip (see Fig. 2 for details).

The majority of respondents, 97.4% use public transport while 2.6% use private car for their travel (see Fig. 3). The shared Taxi which accounts 36% appears to be the dominant means of travel followed by government owned bus, Anbessa (30%) and Sheger (25%) as shown in Fig. 4. The reason behind this is that Taxi is the fastest and comfortable mode while Anbessa and Sheger are the cheapest mode of travel. The least modes used by respondents are Light Rail Transit and Higer Bus which shares 4% and 5% respectively.

Respondents use a combination of modes of transport for their travel as it is presented in Table 3. Taxi transport mode accounts an important share of usage (47%) followed by Anbessa (33.3%) and Sheger (21%) (see Table .3). In addition, Taxi, Anbessa, and Sheger also account highest percentage in terms of being used in several times a week. As can be seen from Table 3, all modes of transport share lowest percentage in being used several times a month. In addition, Higer and Light rail transit have lowest usage in all frequency categories. This is mainly attributed to service coverage. For instance, LRT only has two lines across the city which makes it out of reach for residents living far from the lines.

4.3. Affordability and travel time as measures of transport vulnerability

Fig. 5 shows an estimate of the transport share of household income for different income groups (Affordability Index). The data exhibits considerable difference across different income groups. As can be seen from Fig. 5, affordability index is higher for low- and middle-income groups than high income groups. The value of affordability index is above 20% of household income for 88% of low-income groups and 11.8% of middle-income groups. Again, affordability index between 15 and 20% of household income accounts 59% and 41% for low income

Table 2  
Travel time.

| Total travel time (in minutes) | Category | %    |
|--------------------------------|----------|------|
| <30                            |          | 8.8  |
| 31–60                          |          | 16.8 |
| 61–90                          |          | 10.5 |
| 91–120                         |          | 10.1 |
| >120                           |          | 53.8 |

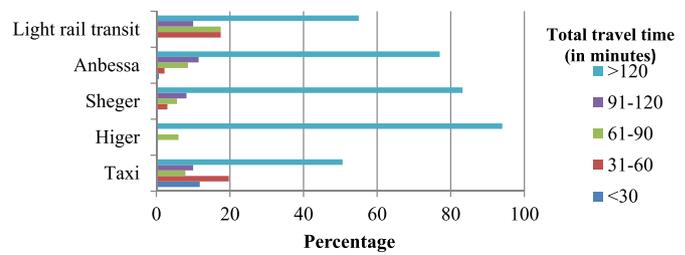


Fig. 2. Travel time by mode of transport.

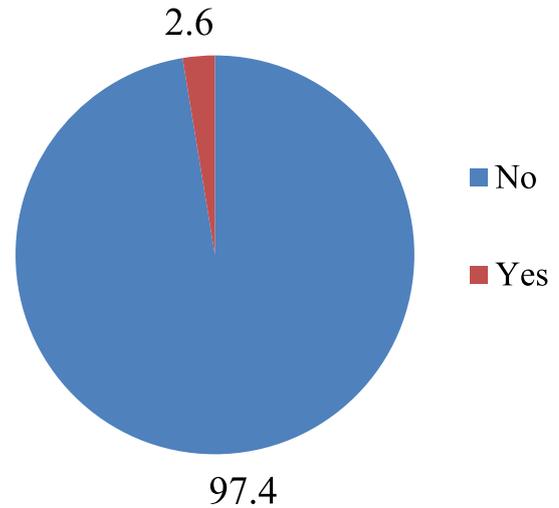


Fig. 3. Private car ownership.

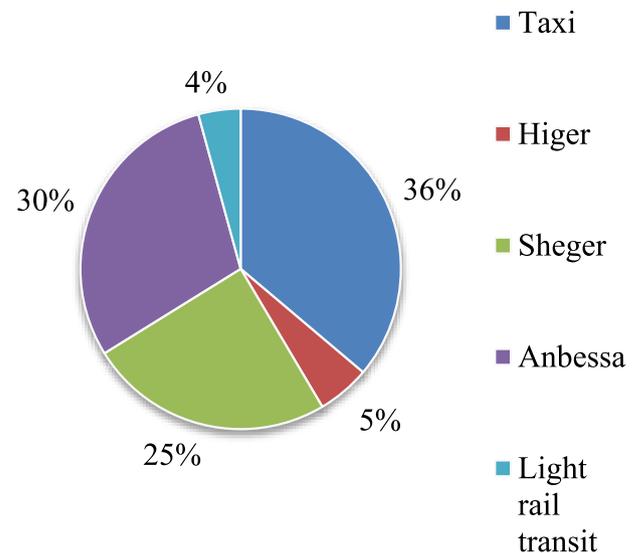


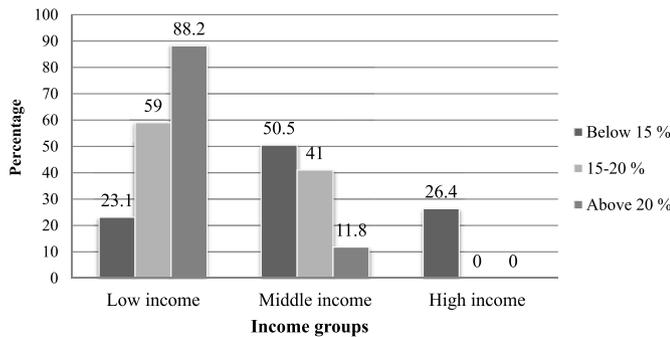
Fig. 4. Modal usage.

and middle-income groups respectively. In addition, 23% of low-income groups have an affordability index of below 15% of income. Transport expenditure (Affordability index) also accounted below 15% of household income for 50.5% of middle-income groups. However, affordability index is below 15% of household income for high income groups, which reveals less financial burden on them.

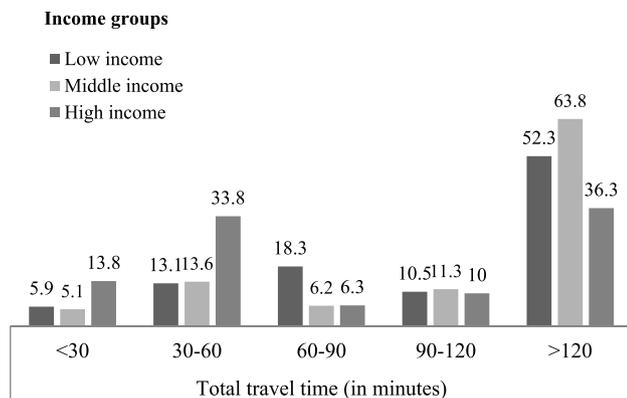
The data from Fig. 6 clearly reveals the disparity in travel time between the various income groups. Accordingly, low and middle incomes groups have longer travel times than high-income groups. Although there is disparity, a significant proportion of all income groups have

**Table 3**  
Modal frequency of usage.

| Frequency of usage      | Taxi  |      | Higer |     | Anbessa |      | Sheger |      | Light rail transit |     |
|-------------------------|-------|------|-------|-----|---------|------|--------|------|--------------------|-----|
|                         | Count | %    | Count | %   | Count   | %    | Count  | %    | Count              | %   |
| Daily                   | 215   | 47.0 | 9     | 2.0 | 152     | 33.3 | 96     | 21.0 | 19                 | 4.2 |
| Several time a week     | 91    | 19.9 | 22    | 4.8 | 87      | 19.0 | 106    | 23.2 | 15                 | 3.3 |
| Weekly (once in a week) | 14    | 3.1  | 6     | 1.3 | 20      | 4.4  | 16     | 3.5  | 1                  | .2  |
| Several time a month    | 28    | 6.1  | 14    | 3.1 | 20      | 4.4  | 19     | 4.2  | 5                  | 1.1 |



**Fig. 5.** Percentage of income groups with different transport expenditure share of household income (Affordability Index).



**Fig. 6.** Percentage of income groups by travel time budget.

longer travel time, more than 2 h due to the commonly shared impact of congestion in the city. In this case, 63.8% of middle income experience a total travel time of more than 2 h and 52.3% of low-income groups but only 36.3% of high-income groups devote a total travel time above 2 h. Again, all income groups have the same proportion in travel time budget between 90 and 120 min 10% of high- and low-income groups have a travel time budget between 90 and 120 but 11.3% of middle-income groups.

High income groups take a higher proportion in the lowest and modest travel time category. 33.8% of high-income groups experience a total travel time in between 30 and 60 min while a small percentage, 13.6% and 13.1% goes to for middle- and low-income groups respectively. A higher proportion, 13.8% of high-income groups have a total travel time below 30 min but a total travel time below 30 min represents 5.9% and 5.1% of low- and middle-income groups respectively. This is mainly because high income groups afford the fastest public transit modes. Low-income groups take a highest proportion, 18.3% in travel time budget above 1 h followed by high income groups (6.3%) and middle-income groups (6.2%).

There are some factors unique to the city of Addis Ababa that more explain the results of travel time and expenditure budget. In physical terms, Addis Ababa is currently expanding at an increasingly rapid rate

and the physical expansion of the built-up area of the city has outpaced the capacity of the city government’s infrastructure and basic urban services (Fikadu 2013; Minwuyelet, 2005, p. 2). The horizontal expansion of the city is also influenced by the development of squatter settlements. This trend is mainly attributed to rapid population growth coupled with high land price and unaffordable rental housing in the city center which has led to the development of informal settlements, mainly in the outskirts of the city (Mesfin, 2009). Another feature in the city’s expansion is the creation of new housing areas in the outskirts of the city. In response to housing shortage, the government has launched an Integrated Housing Development program (IHDP) in 2005 to benefit the residents to own their own home. However, most of these housing units, condominiums, are constructed at the periphery part of the city, further from the city centers, where most of the jobs and services are located. Hence, the changing spatial patterns have exposed people living in the outskirts of the city to be vulnerable to many transit related challenges, mainly cost and time. In the first place, the public transportation, that many residents depend on to access their jobs, is not available in those suburban residential areas (Melkamu, 2019). A study conducted by Fenta (2014), also revealed that those residents living in the outskirts of the city are exposed to rising monthly transport expenses without secured income and they cannot afford the costs of privately owned transportation services from their home to work, which is located in the city center.

Another critical aspect is inflation which has led to rising cost of living. In Ethiopia, the rate of inflation has shown an increasing trend for the past few years, 10.69%, 13.83%, 15.84% in 2017, 2018, 2019, respectively (Robera, 2021). As a result, double digit inflation has become worrying for citizens and policy makers (ibid). In terms of transport, the rising cost of fuel coupled with stagnant (fixed) income has exposed individuals to higher travel expenditure. Furthermore, traffic congestion, which is mainly attributed to poor traffic management and imbalance between vehicle volume and road capacity (Kefyalew, 2017), is also another contributing factor for longer waiting and travel time in the city.

One-way analysis of variance (ANOVA) results.

The one-way analysis of variance (ANOVA) was conducted to test whether there are any statistically significant differences between the means of percentage of income expenditure on transport and total travel time budget among low-, middle- and high-income group.

The ANOVA result suggests that the total travel time scores of the groups (income groups) differ significantly (Table 4). To check for individual differences between groups post-hoc comparisons assessed using Dunnett’s T3. The test indicated that the mean score for low-income groups (Mean = 3.9020, SD = 1.32667) is significantly different from high income groups (Mean = 3.2125, SD = 1.55648). High income groups (Mean = 3.2125, SD = 1.55648) significantly differ from middle income groups. The mean difference is significant at 0.05 level. However, no significant difference is detected between low income and middle-income groups. This is mainly attributed to the similar travel characteristics of low- and middle-income groups. Since they are working group and regular commuters, they share the same travel features in terms of mode choice and trip purpose. Consequently, they may have no difference in travel experiences. The empirical evidence also shows a slight difference between low and middle income in their travel time budget. For instance, 52.3% low-income groups have a travel time

**Table 4**  
One Way ANOVA Results (total travel time difference across income groups).

| Test of homogeneity of variances ANOVA |                     |                    |                         |      |        |      |
|--|---------------------|--------------------|-------------------------|------|--------|------|
| Income Groups                          | Mean                | Standard Deviation | Levene's statistic      | Sig. | F      | Sig. |
| Low income                             | 3.9020              | 1.32667            | 9.162                   | .000 | 13.555 | .000 |
| Middle income                          | 4.1525              | 1.29878            |                         |      |        |      |
| High income                            | 3.2125              | 1.55648            |                         |      |        |      |
| Group differences                      |                     |                    |                         |      |        |      |
| Income groups                          | Mean Difference     | Sig.               | 95% Confidence Interval |      |        |      |
| Low-high                               | .68946 <sup>a</sup> | .003               | .1957 1.1833            |      |        |      |
| Middle-high                            | .94004 <sup>a</sup> | .000               | .4577 1.4224            |      |        |      |
| Low-middle                             | .25058 <sup>a</sup> | .234               | -.0975 .5986            |      |        |      |

<sup>a</sup> The mean difference is significant at the 0.05 level.

of more than 2 h while the equivalent figures for middle- and high-income groups is 63.8% and 36.3% respectively.

Results shown in Table 5 indicate that the percentage of transport expenditure of low-, middle- and high-income transit users is significantly different. The test indicated that the mean score for low-income groups (Mean = 0.2609, SD = 0.39878) is significantly different from middle income groups (Mean = 0.0887, SD = 0.5171). High income groups significantly differ from low-income groups. The mean score for middle income groups is also different from high income groups. The mean difference is significant at 0.05 level.

**5. Discussion of results**

The results of this study revealed that total travel time and percentage of income spent on transport score of all income groups differ significantly. However, the burden is highly pronounced for low- and middle-income groups than high income groups. The literature has also stated that vulnerable groups such as low-income earners often bear a high level of travel burden, as indicated by the percentage of their income used for travel and travel time budget (Zhao & Li, 2016).

The study shows that 63.8% of middle income experience a total travel time of more than 2 h and 52.3% of low-income groups but only 36.3% of high-income groups devote a total travel time above 2 h. Similar to this result, according to Jahangir et al. (2021) public transit users in Dahaka spend more than 2 h in traffic. Travel time also reaches

**Table 5**  
One Way ANOVA Results (transport expenditure differences).

| Test of homogeneity of variances ANOVA |                     |                    |                         |      |        |      |
|--|---------------------|--------------------|-------------------------|------|--------|------|
| Income Groups                          | Mean                | Standard Deviation | Levene's statistic      | Sig. | F      | Sig. |
| Low income                             | .2609               | .39878             | 20.454                  | .000 | 26.454 | .000 |
| Middle income                          | .0887               | .05171             |                         |      |        |      |
| High income                            | .0584               | .03201             |                         |      |        |      |
| Group differences                      |                     |                    |                         |      |        |      |
| Income groups                          | Mean Difference     | Sig.               | 95% Confidence Interval |      |        |      |
| Low-middle                             | .17217 <sup>a</sup> | .000               | .0938 .2505             |      |        |      |
| Low-high                               | .20251 <sup>a</sup> | .000               | .1242 .2808             |      |        |      |
| Middle-high                            | .03034 <sup>a</sup> | .000               | .0176 .0430             |      |        |      |

<sup>a</sup> The mean difference is significant at the 0.05 level.

60 min per trip in Bogota (Teunissen et al., 2014). As it can be seen from the result while all income groups have higher travel time on public transit, low- and middle-income groups take higher percentage than high income groups. This is more likely attributed to the type of mode used. There are obvious variations in travel times between

Riders who use bus and taxi transport modes in the study area. Those who travel by public operated buses have longer travel time than those who use Taxi transport mode. This is because high occupancy vehicles are highly impacted by congestion. Research also suggests that certain groups of society who have longer commute times is not because their jobs are further away but because they use frequently slow forms of transportation such as public transit (Fol & Gallez, 2014). In general, users who rely on public transit for meeting multiple needs on a daily basis are at a disadvantage (Lubitow et al., 2017). Again, the proportion of middle-income groups having a travel time of more than 2 h is higher than low-income groups. This is mainly because, from practical situations, low-income groups engage in low-income activities such as street vending, local drink making and selling that are located within home or walking distance that may not necessitate them to travel daily. However, middle income households are working groups and are supposed to travel every working day.

Considering these variations or proportions other trends can be used to further explain the scenario. Low- and middle-income households are working groups and tend to live in the outskirts of the city where affordable housing is available. Banister (1995) indicated that the rising value of land in the central areas have become too expensive for the poor, and forced them to relocate to the peripheral areas, which ultimately make them vulnerable to higher transport cost and longer travel time. Power (2012) also stated that new residential expansion areas become the scene of new phenomena of social exclusion and mobility poverty. In Addis Ababa, low or almost no transit service is available in the periphery condominium residential areas (Melkamu, 2019). The absences of transit service in those areas make residents vulnerable to higher travel expenditure and spend much of their time waiting for a transit service.

The level of transport expenditure is also quite different between the three income groups. For the majority of low-income group, 88%, transport expenditure accounted for above 20% of average income, compared with 11.8% of average expenditure for middle income. However, for high income groups transport expenditure accounted for less than 15% of average income. These findings are also consistent with the result of Raskin (2010) in Bogota where the poor spend 18% of their income on transportation. Moreover, a study by Zhao and Li (2016) in growing cities revealed that for working family's transportation cost could account for up to 29.6 percent of family income. Another study in US also found out that a typical household spends 20.2 percent of its income on transportation (Lipman, 2006).

For developing countries, affordability is one of the main obstacles for the urban poor to get adequate accessibility (Bocarejo and Oviedo 2010; Falavigna & Hernandez, 2016). For this reason, affordability is not only important as an obstacle for accessibility but also as a source of inequality. The highest Affordability index is observed in some Latin America cities such as La Paz, Bolivia 33%, Santiago, Chile 28%, and Brasilia, Brazil 26% (Carruthers et al., 2005). A study of household transport expenditure in Sub-Sharan Africa also showed that transport accounts for around 15%–20% of household income (Diaz Olvera et al., 2008). This same study also revealed that the difference in transport expenditure between household groups is very variable as poor households spend a greater share of their income on transport than others. It has also been estimated that transport accounts for between 8 and 15 percent of household expenditures in a range of developing countries in Africa (Diaz Olvera et al., 2008).

Considering the combined housing and transport costs, it is suggested that to be affordable, households should be able to meet their basic mobility needs with less than 10% of their household budget, with a range from less than 5% if they have high housing costs (more than

40% of their budget), to more than 15% if they have low housing costs (less than 30% of their budget) (Litman, 2013). Thus, low-income groups with a travel expenditure of more than 20% of income most likely be prevented from engaging or taking up opportunities compared to middle and high income groups with a travel expenditure of less than 15% and 15–20% respectively. It has also been acknowledged that cost of transportation limit individual's participation in socioeconomic activities (Lucas et al., 2016; Schwanen et al., 2015). Other studies also revealed that transit users frequently mentioned the prohibitive nature of transit ticket prices and found to be a barrier for many riders (Lubitow et al., 2017). The study further indicated that, often times, riders had to make difficult decisions and sacrifice important health care or educational needs due to the high cost of transit fares.

## 6. Conclusions and recommendations

Social issues form an important part of the transport policy challenge as the social impact of transport decision-making has been far less well researched and addressed than the associated economic or environmental impacts. Therefore, it has become increasingly important to understand the social implications of transport. So, the main aim of the study was to determine the level of transport vulnerability by analyzing inequalities on public transport affordability and travel time budget among various income groups. The results of the analysis show that there is obvious disparity in the level of transport vulnerability, as low and middle-income groups have longer travel time and higher transport expenditure than high-income groups.

The results also highlight the fact that transport is a major burden for urban residents. The target groups of the study have higher transport expenditure and longer travel time though there is variation among income groups. Longer travel times and high monetary costs for low-income groups are typical of transportation inequity. Hence, those who experience transport inequity are the most vulnerable ones. This study provides knowledge on the burden of transport expenditure, in terms of time and cost, on transit users in the city. The result can be used as an input for improving the travel conditions of various income groups and ensure social equity. The findings also have implication for formulating pro-poor urban policies.

On the other hand, higher affordability index reflects higher transport fare charges on both transport service providers, public and private. This is a closely related issue with transit fare that requires strict fare regulation enforcement. Thus, further research is required on fare regulation enforcement mechanisms in the existing transport system. Public transport is one instrument for achieving social equity. Therefore, transport policy formulation should consider the needs and requirements of various groups of transit users. Finally, this study has only used travel time and expenditure to show the level of vulnerability. However, other transit features such as reliability, availability and so on can be considered for future studies.

## CRedit authorship contribution statement

**Eleni Gebremeskel:** Conceptualization, Data curation, Writing – original draft, Funding acquisition. **Mintesnot Woldeamanuel:** Conceptualization, Supervision, Writing – review & editing. **Berhanu Woldetensae:** Supervision, Writing – review & editing.

## Acknowledgement

The authors would like to thank the public transit users on the selected major transit stations of Addis Ababa for filling the questionnaire and the support provided by Addis Ababa University, SIDA and WCYA is greatly appreciated.

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### Further reading

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